The role of informatics in future freight transport

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THE ROLE OF INFORMATICS IN FUTURE FREIGHT TRANSPORT

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The development of "logistics" in Europe since the 1980's has been leading to a complete integration of transport operations in a global approach of physical flows management. Freight transport has strongly been changing to get appropriate goods to the right place, at the right time and at the lower total cost. Introduction of informatics, one of the technologies involved in "advanced logistics systems", is for sure one of the most relevant evolutions. The purposes of the present paper are to give an understandable view of the current state of informatic systems in use in freight transport, to provide an overview of their incoming evolutions and to evaluate the key-role they will play in this sector.

The paper begins in section 1 with a definition of the "logistics" concept. It presents its integration in European firms management and shows how information and communication systems are important in logistics. Section 2 presents the characteristics of logistic organizations in manufacturing, distribution, and logistics supplying and points out the main trends of logistic evolutions. In section 3, the paper focuses on today's advanced information and communication systems in freight transport management. It points out the so-called "driving-forces" that have been leading European firms to develop such systems and outlines the most interesting ones. As a conclusion, it forecasts the impacts of advanced information systems on the freight transport sector.

1. FREIGHT TRANSPORT: COMPLETELY INTEGRATED IN THE LOGISTIC CHAIN

Since the beginning of the 1980's the traditional narrow view of freight transport limited to haulage of goods has been superseded in physical flows management by the concept of "logistics". Freight transport, considered in this paper in a wide sense as all operations involved in the moving of goods, is now in a logistic chain a simple link like any other operation of the transformation and displacement process.

The Logistics Concept

Logistics consists in a global approach of the whole physical circulation of goods: from raw materials to components to finished products sold to consumers and spare parts for products that have to be supported. This global approach also includes information and financial flows associated to physical flows. What is the aim of logistics? It is to design a cost effective organization able to handle the whole physical circulation of goods and provide consumers with the right service level. Moreover this organization must be easily adaptable to the fluctuations and hazards of markets which are diversifying, changing and becoming international. Logistics is supposed to provide firms with competitive advantages by: cost control upon the whole chain, quality and reliability of products and services, and reactivity to markets and demands. It is now considered as a strategic management function in firms.

Historically in Europe, Logistics has come from transport and has been developed by manufacturers in order to reduce transport costs. In the end of the 1970's, "transport logistics" had been the first step of evolution. Transport was defined as all operations needed to move goods: haulage and services which were previously considered as subsidiary to transport such as storage, handling, warehousing etc. But the optimization provided by transport logistics was limited to non-production sequences. Since the beginning of the 80's, logistics has been extending the sphere of its application to all physical flows - from supplying to distribution through manufacturing- whether logistics activities are contracted out or not.

Now global logistics is a full management process downstream piloted which reconsiders the whole sourcing-production-distribution system to ensure the consistency of

physical circulation. It takes part in deciding who (make-or-buy choice), where (selection of plants and inventories location), in what quantity (with definition of all stock levels), when and at what rate (scheduling) companies should deliver, produce and supply. It also intervenes in the design of products to optimize their life cycle cost improving their transportability and supportability at a good global price with a good associated service level. Therefore logistics is a transverse management function operating at strategic, organizational and technical levels.

Being in charge of the whole physical chain management logistics must at least know the physical possibilities among the potential players in the chain, inform everyone of the undertaken operational decisions, and be informed back of what is happening at each stage of the process. This highlights the importance of information management in logistics to control physical flows and to take the right decisions. Therefore logistics has to organize in direct connection with physical circulation a parallel information and communication system which must help to forecast plan organize and follow the operational process and react against any disruption. At a strategical level this information system must also provide managers with adapted and accurate logistic information indicating the results (speed, quality, cost ...) of the chosen global logistic organization and the forecasts in terms of demands.

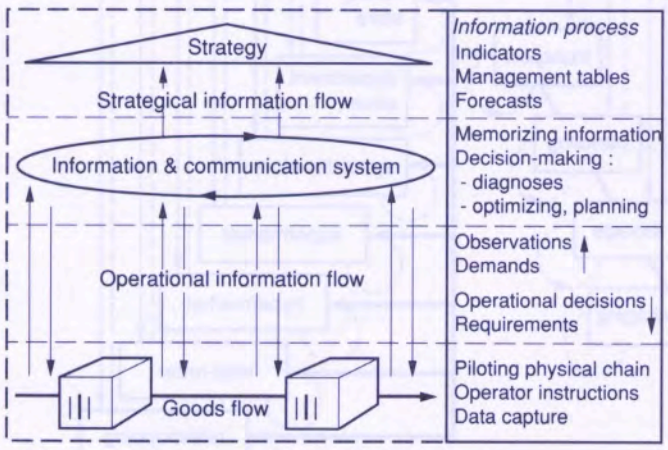


Fig.1 Logistic information and communication system

Logistics is consequently considered as a complex activity which combines a wide range of techniques to handle just as well goods and information. The management of this complexity in a global understanding of the vital links between information technology and logistics management in a competitive business environment is an issue of the so called "advanced logistics organizations" in which advanced technologies like informatics play a key-role. Today logistics managers are the architects and conductors of a multi-technology system involving multi-competence human resources and they undertake cross-function decisions.

Status of Logistics inside European Firms Management

Logistics is an up-to-date phenomenon in European business and the concept is now rather clearly and well understood. But the status of logistics as a truly transverse management function in charge of the whole physical circulation is far from being achieved in every firm. Logistics is actually at various development stages in European firms depending on many internal characteristics (size, products, geographic locations ...) and external factors (markets, competitors, suppliers ...). The fact is that companies that have improved their logistics are often the most competitive ones of their branch. Today's trend in management shows that logistics is to propagate within all firms in all economic sectors all the more because companies are looking for competive advantages. This seems to be the most stimulating factor for logistics development and explains why control of flows is becoming "strategic".

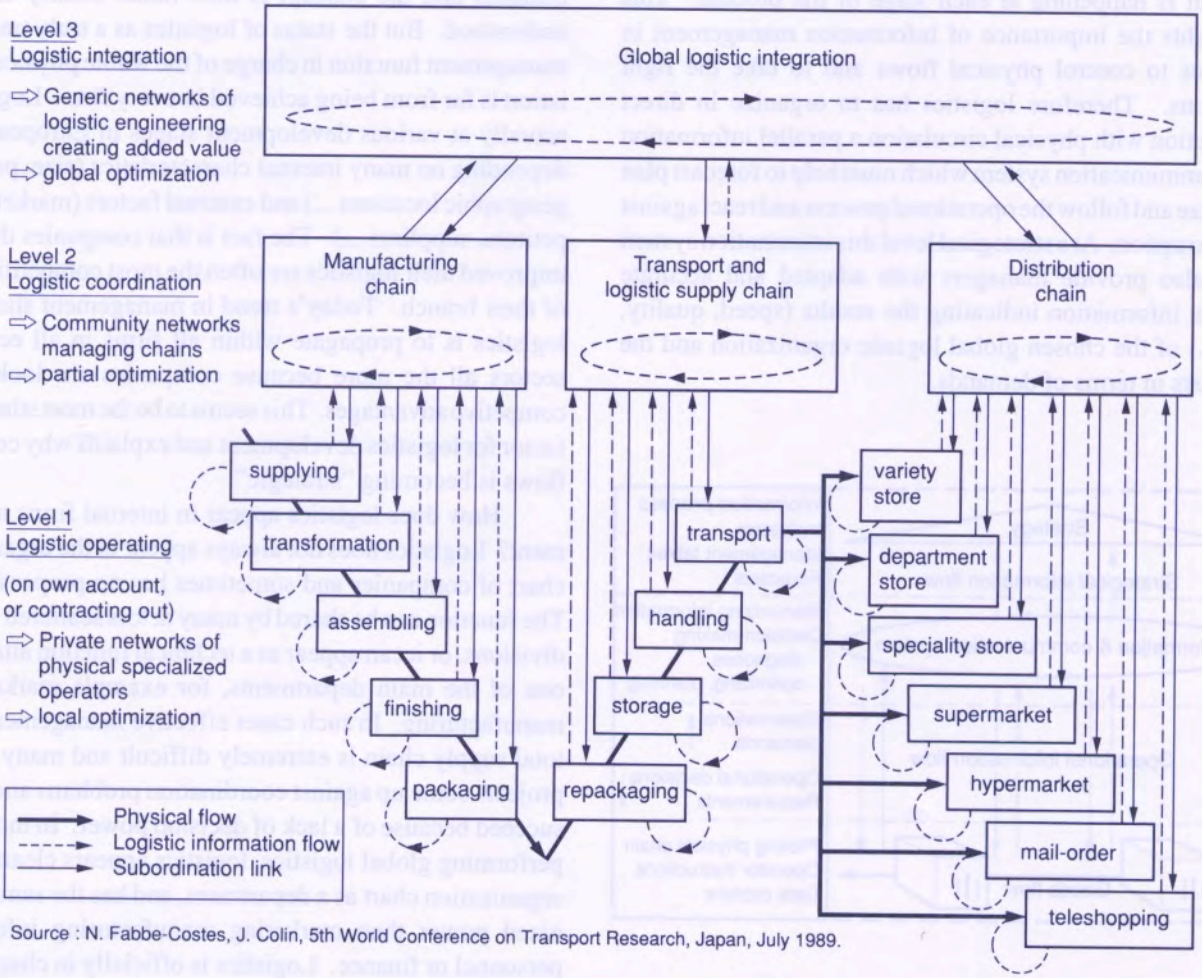
How does logistics appear in internal firms management? Logistics does not always appear in the organization chart of companies and sometimes has no proper identity. The function can be shared by many actors scattered in many divisions, or it can appear as a technical function attached to one of the main departments, for example marketing or manufacturing. In such cases effective management of the total supply chain is extremely difficult and many logistic projects come up against coordination problems and cannot succeed because of a lack of decision power. In most firms performing global logistics, logistics appears clearly in the organization chart as a department, and has the same recognized power than marketing manufacturing informatics personnel or finance. Logistics is officially in charge of all the planning coordination and control of the whole supply chain and can negotiate with every functions in the firm to

develop a really global management of its services. In whatever case physical flows get through many different departments within a company and the logistic approach is of no use if they have no will to work together. The capacity to mix abilities in logistic projects is an important success factor of global logistics which must associate all key functions with close interactions to operate successfully.

Logistics Management among European Firms

Decisions and operations in logistic chains are always shared by manufacturers, transport (or logistic) suppliers and retailers. And this phenomenon is extending with the development of subcontracting activities either in manufacturing or in logistics. As shown in figure 2, if internal logistic management is important in particular to improve the individual profitability of each company (level 1 of logistic management), the ambition of the logistic approach is to optimize the whole chain (level 3) from raw material to final product delivered at consumer places. This global logistics integration demands information systems and communication networks to enable adequate information flows between the large number and variety of players within the manufacturing distribution and transport industries who have to communicate but often use different sometimes incompatible information systems.

What about European logistics management when



Source : N. Fabbe-Costes, J. Colin, 5th World Conference on Transport Research, Japan, July 1989.

Fig. 2 Three logistics management levels

many different companies are involved in chain processing? Most European firms had problems to develop cooperating process until 1985, but they were aware that they would have to improve joint logistic management. Now that most firms are all about at the same level in internal logistics management and look for more quality and cost saving they get interested in improving coordination with their external partners. Many examples prove that it is possible to develop common advanced solutions to co-control physical flows and to co-operate information and communication systems.

2. TRENDS IN LOGISTIC ORGANIZATIONS

Section 1 has proved that freight transport is totally and globally integrated in the logistic supplying-production-distribution chain. In section 2 we are to examine the most important trends in logistic organizations and the most significant impacts they have on freight transport management. To get it more easy, we have broken down the logistic chain into three main fields of coordination (see level 2 in figure 2): manufacturing (supply, production, assembly), distribution and logistics supply.

Trends in Manufacturing Logistics

To supply consumers with an increasingly greater variety of goods, European industrial structures have been changing from a heavy raw-material and technology push production mechanism to light assembly and processing in a market pull mechanism. Marketing and logistics have consequently become more important in manufacturing management in particular because they can provide production with accurate sales forecasts to exactly adapt products and joint-services to consumers demands.

Looking at manufacturing operations, internal productivity has been powerfully improved since the beginning of the 1980's with computerized technologies and automated processes even in small and medium sized companies. And many companies take advantage of technical modifications to improve logistic organization or even to think about the location and specialization of their plants again. The trend in Europe is to concentrate plants and to locate them where excellent transport facilities are available. Manufacturers have also been extending their contracting out to benefit from cheaper man-power or to limit heavy productive investments.

The production process is then broken up in multiple plants located in many countries and held by different firms. In stockless manufacturing the trend is to reduce the overall number of supplies and eliminate those with poor logistic reliability or those located in areas with no possibilities for high transport service.

Problems found in inventory control have been dealt by manufacturing logistics with an increasing attention for the last ten years. Because of the many items that are produced the fluctuation of demand and the competitive environment stocks mean extra costs and risks in particular for finished products. Manufacturing logistics has been promoting "just-in-time" (JIT) organizations which permit steadily declining of stock levels at each step of the process (stocks of finished goods, components and raw materials). Consequently, there are more numerous shipments and more frequent deliveries between various plants and the manufacturing process covers larger distances but with less bulky and smaller quantities transported.

In advanced manufacturing logistics, production has definitely entered the logistics sphere. Production is no longer considered a simple technical transformation process (as it is in a "classic" industrial culture) but as a mixed and complex process, the rhythms of which have to be studied in accordance with the whole logistic chain to produce only what will be or is sold. To perform such systems the whole automation of corporation integrating sales, design and production departments must be achieved as well as computer integrated manufacturing (CIM).

Distribution Logistics

Because distribution logistics takes over finished products up to consumers, it is now recognized as an important part of the marketing strategy within companies. Logistics distribution is considered as a weapon to influence positively the market and increase market penetration, profit and turnover. For that, distribution logistics must be able to respond quickly to market demands and to guarantee delivery time for the product itself and the parts in the logistic support service. Because of frequent changes in ranges and rapid increase in variety of products, retail stores and sales offices unless they have an adequate logistic organization are often unable to keep up coping either with a large

inventory of product types or with consumer demand.

Aside from its impact on manufacturing, logistics has powerfully changed distribution structures in Europe. It has motivated the nation-wide grouping of department stores and large supermarket corporations and the concentration of wholesalers and retailers covering up at least nation-wide areas. Chain stores have taken control of their supply chain and develop logistic management methods to increase both number and surface of stores and enlarge the variety of products proposed to consumers. Most have logistic distribution centers at European national or regional levels that collect from manufacturers products they deliver to retail stores. Logistics enables those distributors to extend their networks and cover Europe and even more. Logistics specialization combined with marketing segmentation has also permitted the diversification of distribution forms: general mass distribution stores (grocery and non-food), specialized mass selling stores (for shoes, clothes, do-it-yourself parts ...), or even nonstore distribution like mail-order selling, teleshopping ...

From the logistics point of view mass distribution is one of the most important phenomenon in Europe because of the advanced organizations that are in process. Chain stores are improving their supplying-distribution management using internal information systems and communication networks within their proper network and with manufacturers and logistics suppliers using EDI systems. Nonstore sales (like mail-order) is another interesting field because the service provided to consumers relies entirely on logistics. Many of those distributors try to satisfy consumer demands rapidly: some of them guarantee home-delivery less than 48 hours after order. Some have improved demand recording by telematics network. Distributors' computers can use immediate order information communicated by consumers without keyboarding. Most have also improved delivering time by operating automatic handling and preparing systems and using express parcel services.

Countracting-out Freight Transport Activities

Today in Europe both manufacturers and distributors -called shippers- are now concentrating on their core business and are contracting out all other services. That means they entrust more and more logistic operations to third party logistics services companies. Since the beginning of the 1980's European shippers have begun to give up transport on their own account. They have been looking for freight hauliers in order to reduce transport costs and enhance service levels of goods circulation. Private professional freight carriers have progressively shown up and motivated a general vertical "disintegration" of transport activities among shippers. The movement of contracting out transport activities (at the beginning limited to haulage) has progressively extended to other logistics operations and services as fast as competences of subcontractors were extending. Figure 3 illustrates the evolution in subcontracting logistic activities. Now almost all the major European manufacturers and distributors work in conjunction with third party logistics specialists, forming partnership to produce innovative common solutions among which information and communication systems play a key role.

With the contracting out phenomenon logistic chains become more and more complex and imply an increasing number of actors. This complexity increases risks if any disruption occurs. Therefore a higher quality in logistics has to be performed by every player. But stakes in offering quality are so important that firms are now conscious of the necessity of working together and finding new cooperation modes in order to detect problems, analyze critical situations, and find correcting actions to perform global quality and effectiveness. It explains why today more than before shippers select one [or only a few] operator[s] as prime contracted haulier[s], who is [are] responsible for all freight transport activities, even if haulage is recontracted out. Global logistics shows closer relationships between shippers and logistics suppliers who adapt the service to the particular needs of their customers. It gives logistics suppliers the opportunity to take a greater part in the economic

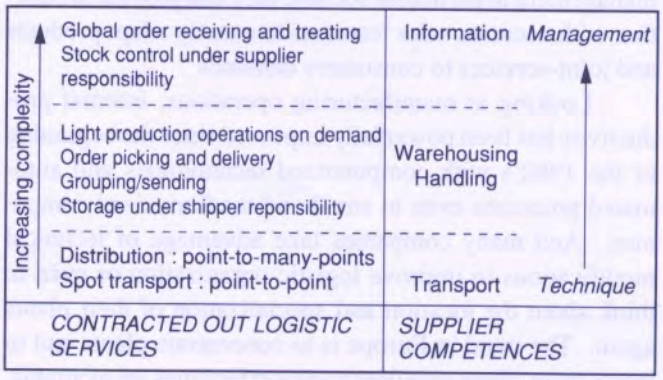


Fig. 3 Evolution of contracting out 'logistics"

field, if they manage to offer a good cost-effective and modular supply of logistic services.

Trends in Logistics Supply

Most European logistic suppliers were previously hauliers who developed break-bulk points and improved their physical network structure to make fleet management profitable. By divorcing storage and break-bulk functions and sometimes performing them in different places, carriers have been able to reconcile conflicting transport and stockholding cost objectives. This kind of "hub-and-spoke" system which combines both full loading (to the fleet profitability) and high frequency delivering (to the service level) is now common in shipping (with ports) and railroads (with marshalling yards) and in road (with transshipment depots). In those "nodal points" logistic suppliers can operate some value-added tasks such as inventory management, order processing, pricing and packaging, and even light manufacturing or assembly. Stock previously held in shippers' own depots are being consolidated in larger warehouses with higher technical specifications set up by specialist contractors, who are often also transport operators. By concentrating inventory in fewer locations they could achieve substantial stock reduction while taking advantage of economies of scale in warehousing (cost reduction in operations). By increasing scale and sophistication of mechanical handling systems, moving towards automated warehousing, they could improve productivity. They also improved terminal facilities and planning systems to organize transport access and eliminate any waiting time of transport vehicles. Above all they worked hard developing information systems to improve management of the many operations integrated in freight transport service. With third party logistics of this kind, shippers could rely on external competences.

This evolution occuring in a hard competitive environment has been leading to ever higher specifications of shipper demands and ever more advanced solutions developed by logistic competitors. Then logistics supply has gone through a real market segmentation with a complete and precise adaptation of physical and information networks. Some types of logistic specializations can be outlined. Specialization by logistic family of products permits to reinforce activities by grouping goods that are logistically compatible with possible shipping round tour, mixed load shipping and scheduled shipping. This specialization exists for example with JIT work-in-process supplying in controlled-temperature or in sensitive (dangerous or polluting) goods transport. Specialization on particular gaps of the logistic market permits economy of scales by becoming the specialist of a special service. Rapid collection and distribution of small shipping quantities (express parcel services), coat hanger clothing delivering, or personal informatic equipment distribution and support are examples of such gaps. A kind of specialization can also be found in developing specific networks to forward the massive flows of goods generated by proactive logistics with high productivity level (with many examples in chain stores distribution), and/or in developing specific networks to forward specific goods generated by a reactive logistics with a high service level (with some examples in providing parts in a dedicated logistic support service).

Towards a Hierarchical Organization in the Freight Transport Sector

Due to the great competition among carriers and the ever declining rates of transport prices and ever increasing of its costs, most European suppliers consider that profits are no more possible if they exclusively perform haulage. This situation has been increased by a general deregulation of freight transport in Europe during the 1980's leading to harsher competition among companies because a de facto ineffectiveness of compulsory rates and an easier access to newcomers (less entry barriers). Reforms in transport regulation have certainly stimulated vitality and creativity in transport urging transport firms to be more shipper-oriented in terms of services and tariffs. Because they are facing a new competitive situation they have to develop advanced logistics and information systems. That explains why many transport carriers are becoming logistic suppliers adding more lucrative logistic services to their basic transport activity. Looking at the logistic chain the fact is haulage is not the most complex operation and has not the biggest share in the overall logistic cost and profit. Some logistics suppliers are even getting rid of the transport activity itself they subcontract to "simple carriers".

The result of the development of advanced highly specialized and efficient logistic systems is the dualism and hierarchy of the freight transport sector. Particularly obvious in road freight transport, this phenomenon is general.

On one side there are transport subcontractors (most of them are small business scale companies) with little autonomy only involved in technical spot haulages with poor added-value. On the other side there are few large-scale chain organizors and managers who benefit from their ability to mobilize multiple actors techniques and networks and competence in managing complex logistic services. They offer to shippers a complete competitive and flexible logistic service and are often able to connect with other networks in particular for international trade. To settle unchallengeable positions they focus on permanent improvement and adaptation of their services. Their physical and information networks which are now extending to a European-wide scale rely on selected "points" (commercial and service offices and logistic terminals) throughout the area they cover. Some of those points can also belong to others complementary logistic suppliers with whom they have some partnerships. Among such logistic suppliers we can notice door-to-door multimodal operators: container shipping companies, air freight express carriers and even specialized rail-road subsidiaries. Their competence relies in building and guaranteeing the quality of the whole international multimodal chain.

European Logistics Trends

The "1993 horizon" has an accelerating effect on both manufacturers distributors and logistic suppliers strategies. Today logistics can no longer be considered outside an European if not world-wide logic. Movements of buying up in the finance arena and decisions in restructuring operations have a great impact on firms relocation. With logistics, firms can concentrate operations in a restricted number of points (sourcing production or distribution centers) while going on with expanding market strategies. Where do they become established?

Logistic units give greater place to transport facilities access and proximity to market and material or manpower sources. With today's information and communication technologies, administrative units can be located elsewhere, nearby finance places for example. From an economic point of view Europe is not a homogeneous territory. There is an important polarization effect on the "golden arc" of Europe (from Netherlands to north Italy, through West Germany) and around big cities which are important consumption and manpower points. Most European or international firms are looking for those locations to settle down. Those choices are possible because European transport facilities permit to irrigate all the European market from a reduced number of points. What are the trends in European transport facilities?

European transport facilities show a multimodal network organization jointed by polarizing points. Those points are often dedicated areas for freight management with multimodal infrastructures and superstructures available. They are always located nearby cities. And we can notice that most logistic activities actually move from inner urban areas where their efficiency is impaired by difficult vehicle access, lack of room for expansion, and often antiquated buildings, to those decentralized and specialized areas. In fact the "non-homogeneity of Europe" leads to an organization into a hierarchy of different logistic networks to perform high service level through the whole European market. Logistic points (platforms, depots ...) perform effective synchronization between those networks.

But this polarization does cause problems in particular related to congestion and pollution. This is all the more true because freight transport mostly relies in Europe on road haulage. Today's dramatic clogging of most networks in northern Europe and of some routes shows the limit of logistic concentration in Europe even if infrastructure projected will keep on improving cross-country links for all networks in particular highway and high speed railway networks but also waterland connections. Rapid development of south European countries will also probably influence new strategies favourable to south Europe also widely opened to extra-European international exchanges with the Mediterranean Sea. European freight transport is facing a new situation and nowadays logistic solutions will undoubtedly have to be reconsidered.

3. ADVANCED L.I.C.S. (LOGISTIC INFORMATION AND COMMUNICATION SYSTEMS) IN FREIGHT TRANSPORT

With the increasing complexity of European logistic chains presented in section 2, it becomes obvious that logistics can no longer be efficient without modern management information and communication systems using so-called "new technologies". As we said in section 1 (see figure 1) they operate at three management levels. At the

operational level they can pilot physical automated means, give instructions to human operators, and ensure automated or keybording information capture. At the tactical level they perform all logistics management decisions such as global planning optimizing and running of physical flows if possible directly driven by the market and completely real-time and online connected to physical circulation. Decision support systems at the strategical level help in the audit of the existing organization and the design of future logistic networks.

Main Objectives of Advanced L.I.C.S.

In Europe use of advanced technologies in freight transport management was, in a way, a response to crisis. Informatics and telematics have helped firms to reduce costs and provide them with differentiation and innovation of logistic services. In that field introduction of new technologies has two main objectives: first productivity and after reliability.

With informatics many easy management operations can be automated and many others can be simplified. The results are faster and safer information processing and manpower saving. Moreover informatics permits to develop decision-making systems in planning and optimization: And global productivity is increased by direct connections between informatic applications with communication systems providing better coordination and integration. The search for eliminating inefficiencies (looking for zero delay, zero inventory, zero default, zero red tape) is certainly one of the dynamic factors that has pushed logistics to develop advanced information and communication systems. L.I.C.S. as a productivity support is now fairly generalized in Europe.

Firms are now looking for L.I.C.S. as a support of logistic organizations' reliability. The objective of global logistics is to ensure the quality of physical flows at the minimum cost by continuity and fluidity of the flows and reactivity of organizations to cope with markets fluctuations. Reliability of logistic chains has become a real challenge because any disruption of physical operations would lead to a loss of production or sales. With a higher tension of flows any delay can paralyze the downstream links in a chain and its effects can spread throughout the whole chain (downstream and upstream). Any disruption can ruin overall logistics performance and cost benefits all the more rapidly since the organization is zero-stock. The more tensed the logistics chain is, the more important the extra-costs induced by poor quality can be. Any error leads more and more frequently to direct extra costs or to an indirect disruption of service. If hazards like traffic-jam crashes or bad weather conditions are unavoidable in logistic operations they must absolutely be overcome. For that L.I.C.S. must follow through of all operations in order to detect and diagnose dysfunctions and activate backup networks to overcome negative effects of hazards. It explains why tracing and tracking functions covering all the logistic network are becoming so popular.

This short presentation of objectives of L.I.C.S shows that advanced logistic organizations rely on both informatics systems for data memorizing and computing and telematics for communication within each company and among logistic partners.

Logistic Information Systems: Informatics Applications

Computer equipment level rates have been constantly increasing in Europe from the 1980's until now. Today more than 85% of companies have computers. But this average rate hides significant differences between economic branches. Freight transport seems to be one of the less advanced but the apparent gap between shippers' culture and that of transport operators is not so important. In fact informatics penetration in this sector follows exactly the hierarchization described in section 2. Most small "exclusive hauliers" are poorly equipped but global logistics suppliers have strongly invested in information technologies. We must also notice that the ownership of computers gives no information about their effective use. Again there is a great diversity in the way firms use computers. Among the many applications that can be observed logistic ones are often the more recent. It certainly explains why only a few firms have a complete integrated logistic informatics subsystem. What are the logistic advanced applications of informatics that can be outlined?

Manufacturers have developed computer-aided manufacturing assembling sourcing and inventory control. Those applications are generally integrated and coordinated into a global system either in the MRP (material requirement planning) or the JIT model. They are also in general interfaced with computer-aided design systems and with sales applications for customer orders processing and sales

forecasting. Logistic manufacturing informatics at the management level can be interconnected with others informatic systems at the process level for online piloting of automated machines.

Distributors have developed logistics computer systems for purchasing decisions and inventory management. Those applications are interfaced with stores' management systems to have market-pulled flows. This is all the more easy because bare-codes are on most products and optical scanners widely in use permit online capture of consumers purchases information. Purchasing applications in nonstore distribution are jointed with consumer order capturing systems sometimes supported by home-telematics systems (like the French Minitel).

Many transport companies run informatics applications for fleet management (optimization of haulage means, containers, empty packages or pallets) for route planning and cargo loading. Those systems are interfaced with shipper demand management systems defining constraints that have to be respected. They are complemented by vehicle-tracking systems via radio-guidance or satellite systems like the European Euteltrack or the worldwide Inmarsat system. Vehicle-tracking can evolve towards online revise routing applications sometimes communicating with onboard computers. In this field we can outline that European research programs are working on developing informatics-based travel services (digital maps and access to information data bases) traffic control facilities in particular in urban areas (gathering information regarding traffic conditions and giving real-time information to drivers for safe and smooth flow) and computer-aided navigation help (localization, online optimization of route regarding traffic congestion situation) that could be be connected to vehicles-tracking systems. Hauliers also have computer-aided maintenance of their equipment in particular for those operating on critical paths of logistic networks. Those systems connected or not to dispatched equipment help in maintenance planning and can include onboard fault-diagnoses systems which help drivers to repair by themselves.

Logistics suppliers with platforms and depots have also warehousing applications generally linked to automatic material handling sorting or packaging. They include product-tracking systems from receipt to storage and dispatch with automatic identification systems by bare-codes magnetic tag or else. They also are connected to space allocation optimization systems deciding where to store goods. This kind of warehousing system is in general associated to computer-aided maintenance managing reliability of equipment in particular static ones located at bottlenecks. Warehousing systems are always connected to computer-aided inventory management including stock control and valuation, order preparation in accordance with requirements, purchase order optimization to limit stocks and avoid to be out of stock.

But logistics efficiency does not result from the accumulation and juxtaposition of systems. Internal profitability of each link and the global profitability of the whole chain can only be realized through the synergism between the multiple systems that are developed as shown in figure 4. The introduction of network-wide online information system is necessary first within each company then between all logistics partners. This is the role of internal and external communication systems.

Internal Communication Networks

Most shippers and logistic suppliers are now (see section 2) operating in an international area and their logistic chain is setting through many locations. Then L.I.C.S. must ensure efficient freight transport control and conduct quick efficient and error-free processing of the enormous clerical work and communication created by logistics. All logistic partners are improving internal communication among their headquarters, branches logistic units and local business offices to collect and distribute up-to-date and accurate corporate news about logistics processing. The result is that administrative work related to physical flows is no more compulsorily done in the same places than physical operations. Delocalization and consolidation of information and decision processing with a redistribution of powers within companies is now a general trend.

Internal communication network can be considered as the first "easy" step of global logistics communication because even if making many different computers and applications communicate always causes technical problems, communication is within the sphere of responsibility and power of the firm. It is not the case of external communication. That can explain why "inner-firm applications" have come long before (10 years approximatively in Europe) "distributed applications" with advanced inter-firms communication networks.

External Communication Systems: EDI Networks

Global logistics shows that flows management cannot be restricted by the borders of a unique company but is widening out to all firms involved in a logistic chain. Logistics cannot reach its objectives (adapted global cost and service level) if there is no cooperation nor communication between the various economic actors. Because many of the partners linked in the "logistic network firm" are scattered, there is a need for powerful communication networks and common information systems. Only direct connections between shippers and logistics suppliers can guarantee that physical flows will not be slowed down because of inefficient information processing whether they are paperless or not. Without fast communication it is almost impossible to ensure reliability of physical flows and to develop global shipment tracking and inventory control systems which can accurately identify location of goods, stock levels and make sure the network is operating normally. Such systems can be observed in express parcel services or multimodal door-to-door container services. They are based on a network-wide online system with common identification of lots and consignments with a codification or symbolization standard. In every point in the transport process (where a parcel is collected, where it arrives or comes out at each terminal, and where it is delivered) information about the parcel is captured and transferred to a host computer through communication lines. Therefore the computer keeps track of the location of all parcels all along the chain and can detect any error in physical circulation.

Today's status of informatics in logistics certainly explains the actual interest in EDI (Electronic Data Interchange) technics to support external communication. Many EDI systems are developing in Europe. Even if all of them are not dedicated to logistic interchanges they all play a key-role in logistic management. All of them are looking for quick accurate easy ordering, shortened delivery time for a

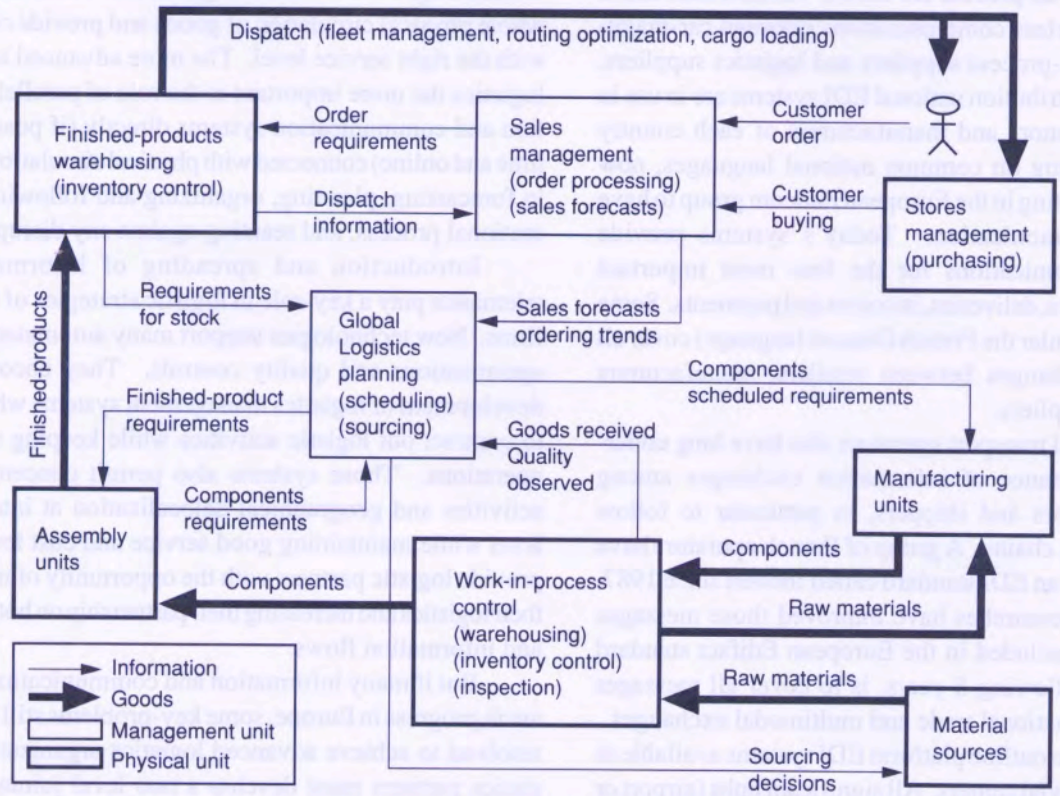


Fig. 4 Logistics information systems

required quantity of goods, preventing from getting out of stocks while reducing all inventories, and above all look for significant reduction in clerical labor hours, in processing errors, in returned goods (reduction of incorrect delivery) ... EDI systems that have been developed during the past 5 years are sector-based (mass distribution, chemistry or electronic industry, car-manufacturing etc) and often nationally-limited. The 1993 horizon gives a powerful stimulation for European-based networks and applications. What are the EDI examples that have interest from the logistic point of view?

Communication between informatic systems is particularly important in just-in-time manufacturing. European car manufacturers have this experience. They have found it impossible to reduce stock levels and produce cars with JIT techniques without cooperating with all their industrial and logistic suppliers and of course their car-distributors. They worked together in the European sectorial group called Odette and succeeded in building a common EDI standard to co-manage work-in-process JIT flows. An EDI network is performing paperless communications between car-manufacturer, work-in-process suppliers and logistics suppliers.

In mass distribution national EDI systems are in use in Europe. Distributors and manufacturers of each country have been working on common national languages, now they are coordinating in the European Eancom group to have a European harmonization. Today's systems provide paperless communications for the four most important documents: orders, deliveries, invoices and payments. Some of them (in particular the French Gencod language) cover all information exchanges between retailers, manufacturers and logistics suppliers.

Multimodal transport operators also have long understood the importance of information exchanges among transport operators and shippers, in particular to follow through complex chains. A group of French operators have been working on an EDI standard called Inovert since 1987. European Cost researches have improved those messages which are now included in the European Edifact standard which, in the following 5 years, is to cover all messages needed for international trade and multimodal exchanges.

We can also outline platform EDI systems available in logistics multimodal centers. All significant hubs (airport or harbour) in international transport have built their own multi-component information and communication systems. Every firm involved in a transport chain passing through the hub can dialogue with this system to get information about links and schedules, to order operations and to follow through its shipments. Those nodal point information systems are interfaced with customs declaring systems. For logistics suppliers operating in the hub, the system helps in traffic control, transport access schedule and goods handling and processing. Finally, the "EDI galaxy" progressing in Europe with the Edifact standard integrating financial flows can be modelled as shown in Figure 5.

4. CONCLUSION

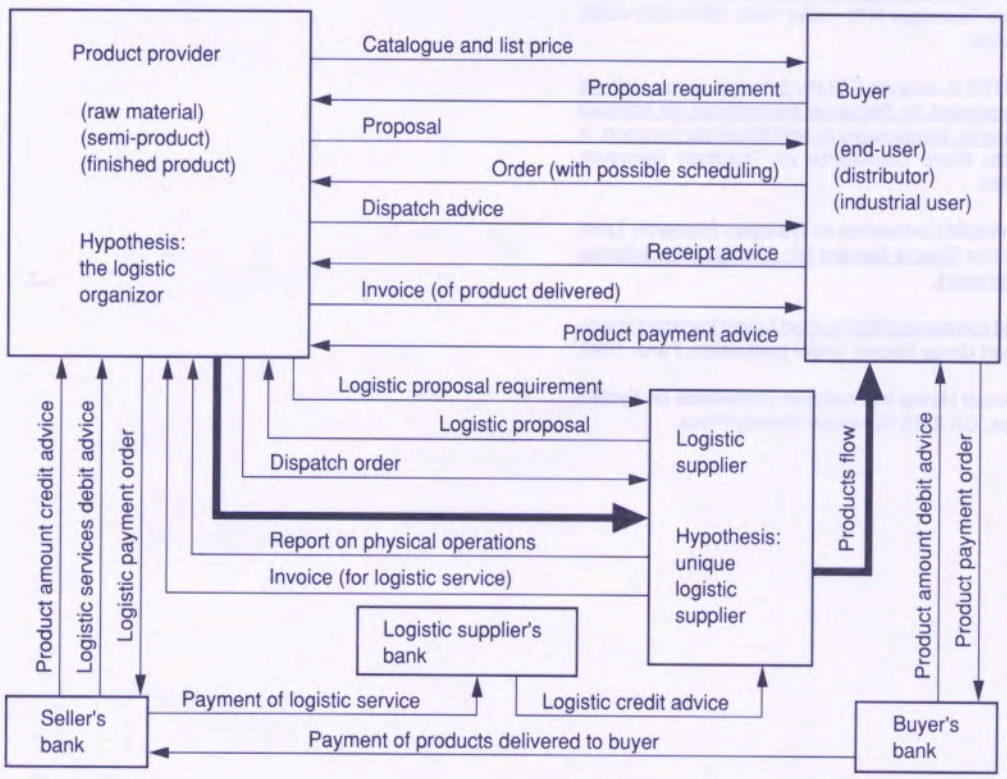
Freight transport is now completely integrated in the logistics approach which is a current management process in Europe. Logistics is a transverse management function operating at strategic, organizational and technical levels which designs cost effective organizations able to handle the whole physical circulation of goods and provide consumers with the right service level. The more advanced is physical logistics the more important is the role of parallel information and communication systems directly (if possible real-time and online) connected with physical circulation, helping in forecasting, planning, organizing and following the operational process, and reacting against any disruption.

Introduction and spreading of informatics and telematics play a key-role in logistic strategies of European firms. New technologies support many automated logistics optimizations and quality controls. They encourage the development of logistics management systems which allow to contract out logistic activities while keeping control of operations. Those systems also permit concentration of activities and geographical delocalization at international level while maintaining good service and cost level. They provide logistic partners with the opportunity of integrating their logistics and increasing their partnership on both physical and information flows.

But if many information and communication systems are in progress in Europe, some key-problems still have to be resolved to achieve advanced logistics organizations. Logistics partners must develop a two level jointed system. The first level is the internal communication among their proper locations in general with internal language. The

second level is a cooperative communication with their logistic partners to improve the coordination of the whole logistic chain and to optimize physical operations. Those global systems are in general very expensive to build and greater competition make their development every day more difficult even if they can provide firms with better quality, differentiation and innovation. Only a few companies, probably the biggest ones, will succeed in developing global advanced logistic systems. In the freight transport sector in particular, the immense scale of some non-material investment ploughed back into computerized systems will probably create an irreversible situation. In some high transport services entry-costs to any newcomer will be so high that there will be no other choice than to join the organization and pay the price for it or to disappear.

But money is not the unique problem. Logistics information and communication systems are getting more and more complex and must be designed at the same time, if not before the physical network. Design, operating and improvement of logistics physical and information networks demand new know-how in logistics management, information processing, and marketing. Firms that do not make today's "non-material" investments to a speed-up general development of their know-how take the risk of being out of competition in a very few years. Logistic management at international level will accelerate the development of advanced logistics systems, and will probably put through a riddle all firms. The "mono-firms" nationally-centred will probably be marginalized. Those who will not have information and communication systems will probably be subcontractors of major companies to which they will probably "pay access" to their networks. This is the challenge European firms are facing and advanced logistics is a powerful weapon they will use in international competition.



Source: N. Fabbe-Costes, adapted from Edifact documents, 1992

Fig. 5 EDI environment of logistics

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